



## **Technical Memorandum (TM #1)**

### **Summary of Data Collection**

Contract C-13412

The Reevaluation Of The C-51 Basin Rule

December 30, 2002

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## **Summary of Data Collection**

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## **Summary of Report**

TBE prepared this Data Collection Report in response to SFWMD Contract Number C-13412. This report constitutes Deliverable Number 1 in accordance with the contract terms and conditions. The initial submittal of the Draft Report was on November 1, 2002 and the incorporation of all external comments, and follow-up meetings, has delayed the finalization to this date, December 30, 2002. Since the finalization of this report was not a “critical path” item we anticipate no schedule slippage for the balance of the study. The extra time spent checking and cross-checking with the local experts was well-spent as it will save time and enhance the credibility of later phases.

In addition to the written documentation within this report there are eleven CDs attached as Section K with all data and model information, including the most recent releases of the hydrologic and hydraulic computer models.

The major output of this report, in addition to the benefits to be derived by having all of the relevant data centrally located, is the delineation of the sub-basin and overall basin boundaries of the C-51 watershed. Many of the changes between this report and the study completed in 1984 are directly attributed to permit actions authorized by the South Florida Water Management District. To the extent practical, we have also provided flexibility within the report and model to allow the District and their contractors to utilize this information for a myriad of other investigations which are ongoing and anticipated under the Comprehensive Everglades Restoration Program.

The major changes in the boundaries of the C-51 basin occur along the northern boundary adjacent to the City of West Palm Beach Water Catchment Area, also known as the Grassy Waters Preserve. Two key variances from the 1984 basin boundaries are the northern extent of the M-1 Acreage area which can contribute flow to C-51 under select conditions, and the modification of the sub-basin along the north side of Okeechobee Boulevard and the west side of the Florida Turnpike. The M-1 Acreage area can physically bring stormwater from as far north as Northlake Boulevard via the internal canal and structure network of the Indian Trails Improvement District. In addition, two developments: Stonewal and Cramer have the ability to discharge into the ITID system such that water from those sites could also reach C-51. On the north side of Okeechobee Boulevard the area which can physically contribute storm flows to C-51 consists of a 1-mile high strip of developments along Okeechobee for a distance of about 3 miles west of the Turnpike. The rest of the area north of Okeechobee and west of the Turnpike now contributes their water to the City’s Water Catchment Area.

A minor change has occurred in the northern boundary of the basin just east of I-95 wherein the City of West Palm Beach’s Stormwater Master Plan has changed the direction and flows between the C-51 and C-17 canal basins.

The information within this report and the delineated sub-basin boundaries have been reviewed and concurred with by an External Technical Review Team made up of local

experts and professionals with intimate knowledge of the basin stormwater systems design and operation.

This information will be utilized in the next steps of this study for computing the hydrologic characteristics of the sub-basins, such as the Runoff Curve Numbers and runoff hydrographs for combination flood routing for the two design storm events: the 10-year, 72-hour and 100-year, 72-hour storms.

# Project Work Plan

## Reevaluation of the C-51 Basin Rule

### Task 1: Data Acquisition

***Sub-Task 1.0: Project Kickoff Meeting and Work Plan (September 4, 2002).*** The purpose of the meeting is to introduce the South Florida Water Management District (District) project staff to the TBE team members, discuss general expectations, and familiarize the TBE team to relevant ongoing interagency projects and the individuals involved. A detailed work plan will be developed documenting all the procedural details and milestones.

***Sub-Task 1.1: Modeling Data Collection (September 4, 2002 to October 28, 2002).*** The various types of data that will be collected during this project include land use, surveyed cross-sections, drainage structure inventory, structural details (as-built plans), soils maps, topographic information, hydrologic and hydraulic time series data, and existing permit information and memorandum of agreements. The inventory of drainage structures (hydraulic facilities) will be documented using a database. We have extensive experience in developing Access database for inventory of stormwater drainage structures, which can provide retrieval of information for modeling and report preparation in various formats.

Data Collection - The various kinds of data that are relevant to this project are listed below. These data types along with other relevant information, if available, will be collected.

- GIS Coverage: Land Use, Soils, Drainage, Topographic, Impervious cover
- Time Series: Flow/Discharge, Water Level, Water Surface Elevation, Rainfall, Control Structure Operation Log (pump, gate, spillway, etc.)
- Survey Information: Cross-sections along C-51 and Other Drainage Features
- As-built Plans and Drawings: Control Structures and Other Drainage Features
- Field Reconnaissance: Drainage Features and Basin Delineation
- Documents, Logs, and Reports: Operating Criteria, Design Reports, Permit Information, MOA/MOU, Previous Methodologies and Sub-basin Reports, Existing Rule
- Modeling Documents: Previously developed relevant models (small or large scales, hydrologic or hydraulics)
- Structural Information: Dimensional Details of Hydraulic Facilities/Structures
- Rules and Other Relevant Information

Data Sources - An efficient coordination process, as described in the previous sub-section is essential to successfully obtain all relevant data from various sources, some of which are given below. The data collection may extend to other sources, and will be updated as appropriate after a detail discussion with the District Project Manager and the technical team.

Project Work Plan  
Reevaluation of the C-51 Basin Rule

- SFWMD (Permitting Section, DBHYDRO Data Retrieval, GIS Division)
- USACE (Hydrology and Hydraulics Section, Engineering Division)
- Palm Beach County (Public Works, Utilities Department, IT, Property Assessment Division)
- Local Drainage Districts (Loxahatchee Groves Water Control District, Indian Trail Improvement District, Lake Worth Drainage District, Village of Wellington/Acme Improvement District)
- City of West Palm Beach
- USGS
- NRCS
- NOAA
- FDOT (Drainage Division, Mapping Division)
- EPA STORET (Hydrographic Data Retrieval)
- Other Relevant Sources

Data Types and Compilation - The above data is expected to be in various formats, such as hard copy, data tables in electronic format, databases, GIS coverage, etc. All data collected during this study will be cataloged (including data source, date obtained and date of data) and meeting minutes will be logged and maintained for potential use during the project. The data sources will be presented with the contact details and a summary of the data contents. Any special information about the data sets will be documented so that the data evaluation and quality control of the data can be satisfactorily completed.

All data collected during this project will be evaluated and field verified, where appropriate, prior to use of these data for modeling of the system. A brief description of the data evaluation and verification process that will be employed during this project is given below.

- Perform consistency check on all data sets that are collected during this project. This will allow in detecting potential gross errors in the data sets.
- Perform error analysis to isolate the outliers in the data sets.
- Perform missing data evaluation on the hydrologic and hydraulic data sets, if appropriate.
- Develop preferred data sets for the hydraulic and hydrologic data sets similar to the preferred data sets in DBHydro database, if appropriate.
- Conduct field verification of the primary drainage structures and confirm the sub-basin delineation. The actual extent of field verification process, including spot elevation measurements, will be discussed with the District Project Manager during the contract negotiation period.

***Sub-Task 1.2: Field Reconnaissance (September 4, 2002 to October 25, 2002).*** We will conduct a field reconnaissance to verify the basin and sub-basin delineation within the study area. This will also include verification of the drainage structures and flow controls. The emphasis will be on documenting the hydraulic connections to the primary canal system. Any photographs obtained shall be included in the report.

***Sub-Task 1.3: Topography.*** We will collect available topographic data from the District and then will apply a digital terrain model to develop the distributed map that can be used for

hydrologic and hydraulic modeling tasks. The final digital terrain model, after being checked for quality control and after the modeling is completed, will be transferred to the District as a deliverable in a later task.

***Sub-Task 1.4: Coordination (September 4, 2002 to September 1, 2003).*** Coordination with CERP and the Army Corps of Engineers is a key process element of this project. The parameters for modeling and must be coordinated with the Corp and District to ensure the federal flood control simulations are consistent with those programs. Initial contacts with District and Corps operational personnel will be made during the data collection phase. Formal operational discussions will be conducted during the delineation of the modeling scenarios.

***Sub-Task 1.5: Documentation (Technical Memorandum TM#1) (November 1, 2002).*** A draft technical memorandum or Data Report will be prepared and submitted to the District for review and comments. The report will document and include copies of all data collected during this study, except for voluminous District permit staff reports which reside within the District's Regulatory Department. In addition, data evaluation for consistency and quality control results will also be documented in this report. The final digital terrain model, however, will be submitted at a later date. The Final Data Report will be submitted after the official review comments from the District are incorporated. The initial boundaries of the basin and sub-basins will be identified in this report, based upon the information collected. The use of the sub-basin breakdown will be contingent upon acceptance by the District and Review Team.

**Deliverables:**

- Kickoff Meeting Minutes
- Work Plan
- Draft Data Report (TM #1)
- Final Data Report

## **Task 2            C-51 Basin Modeling System**

***Sub-Task 2.0: Model Selection (October 31, 2002 to May 1, 2003).*** The modeling system will generate sub-basin discharge and stage hydrographs, route the runoff through sub-basin storage components that are representative of the stage versus storage relationship within the sub-basins, and route the outflows as inflows through the primary canal system. The model will be capable of limiting outflow from each sub-basin according to a user-defined discharge coefficient. The sub-basin storage component will represent the storage within existing stormwater systems and the terrain of the sub-basin using topography, permit files, other reports and studies. The Contractor will use the HEC-HMS hydrologic routing model to generate the sub-basin runoff hydrographs. The hydraulic model used will be HEC-RAS which will be able to simulate unsteady flow conditions. This hydraulic model is able to accurately simulate all features (existing and proposed) of the primary canal system including, but not limited to: bridge crossings, in-line spillways, pumping stations, overbank storage and conveyance, off-line storage facilities, and a water control structure as a downstream boundary condition. The hydraulic model will report flow and water surface elevation time series at points throughout the model domain.

***Sub-Task 2.1: Design Storm Development (December 1, 2002).*** The 10-year and 100-year, 72-hour design storms shall be used in this study. The Contractor shall develop the rainfall ordinates for these two storms with guidance provided by the District. Also with guidance by the District, the Contractor may apply an area adjustment factor to the rainfall amounts if it is deemed appropriate.

***Sub-Task 2.2: Generation of Sub-Basin Runoff Hydrographs (February 1, 2003).*** The Contractor shall generate runoff hydrographs for each sub-basin for both design storms, using a hydrologic method acceptable to the District. Runoff hydrographs generated shall reflect present conditions (land use, percentage of impervious cover, and characterization of how much of the sub-basin discharge is permitted). The Basin Rule requires that the post development discharge rate does not exceed pre-development discharge rate during a 10-year, 72-hour design storm. The pre-development discharge rate is calculated using the sub-basin allowable discharge coefficient. The sub-basin hydrology and the rule, using the discharge coefficients, have to be modeled. It is envisioned that modeling of the discharge coefficients may occur either inside the hydrologic or the hydraulic model. The maximum discharge and water surface elevation shall be reported for each sub-basin.

***Sub-Task 2.3: Development of the Hydraulic Model (April 1, 2003).*** An unsteady hydrodynamic flood routing model shall be developed by the Contractor to evaluate the performance of the C-51 canal system during the design storms. In addition, maximum water surface elevations resulting from simulations of the 100-year, 72-hour design storm will be used to revise Figure 41.9. The model need not be two-dimensional but must be able to accurately handle the suppression of sub-basin runoff in accordance with the C-51 basin rule. Key assumptions of modeling parameters made by the Contractor will be coordinated with the District and reviewed by the External Technical Review Team. The District will provide the Contractor with any modifications or direction following this technical review.

The Contractor will consider previously developed hydraulic models for this basin in formulating this hydraulic model. For example, the FEMA study utilized UNET to simulate the performance of C-51, and the Corps of Engineers used HEC-RAS for design of the C-51 canal system.

The Contractor shall demonstrate that the hydraulic model adequately represents the current C-51 canal performance. Calibration is required; the nature of calibration will be determined by the quality of existing models or best available data. The Contractor may be able to demonstrate the model's adequacy with unsteady- or steady-state simulations of design storms, but shall demonstrate that the hydraulic model executes properly using both design storm runoff hydrographs. The calibration process shall compare observed versus modeled stage profiles and discharge rates for the C-51 canal system.

***Sub-Task 2.4: Documentation of C-51 Basin Modeling System Development (TM #2) (May 1, 2003).*** The Contractor shall provide a technical memorandum to the District, documenting the modeling system development, insights gained during testing of the modeling system, sensitivity analyses and any limitations the modeling system may have.



- Deliverables:**
- Model Selection Report
  - Draft Model Documentation Report (TM #2)
  - Final Model Documentation Report

**Task 3: Model Application**

***Sub-Task 3.1: Baseline Simulations (May 30, 2003 to July 1, 2003).*** The Contractor shall simulate the 10-year and 100-year, 72-hour design storms with the existing basin rule criteria in effect and with all features of the federal project in place and operational. The features include existing coastal water control structure S-155, divide structure S-155A, STA-1E and pumping station S-319. The District will inform the Contractor how these features will be operated. These two simulations will be named the 10-year and 100-year baseline simulations, respectively. Using the modeling system, the design storm runoff shall be routed in each sub-basin. Discharge from each sub-basin for the 10-year, 72-hour event shall be limited by the respective allowable discharge according to the basin rule. This includes sub-basins that have zero allowable discharge. Performance within sub-basins and in the primary system shall be observed. The Contractor shall report the maximum water surface elevation profile in C-51 along the entire length of canal for each baseline simulation and document locations where the water surface elevation exceeds the top of bank.

***Sub-Task 3.2: 10-Year Design Storm Simulation (June 30, 2003 to August 1, 2003).*** Next, the Contractor shall evaluate the 10-year, 72-hour design storm event with modified allowable discharges from each sub-basin. The allowable discharges shall be increased for all sub-basins to a minimum of one inch per day. Where allowable discharges are currently greater than one inch per day, the existing allowable discharge shall be reflected in the model. In the Loxahatchee Groves Water Control District (LGWCD) the allowable discharge shall be increased to three inches per day as described in the STA-1E I/STA-1 W Project. The results shall be summarized in a revised Figure 41-8 of Rule 40E-41.263 and revised rule language.

***Sub-Task 3.3: 10-Year and 100-Year Design Storm Simulations (June 30, 2003 to August 1, 2003).*** The Contractor shall apply the modeling system (with project conditions) for the 10-year, 72-hour design storm and the 100-year, 72-hour design storm during this subtask. The Contractor shall determine the maximum water surface elevation in each sub-basin for the 10-year and 100-year storm events. The Contractor shall conclude this task by drafting revised rule language and developing a figure similar to Figure 41-9 of 40E-41.263 that is congruent with its recommendation.

***Sub-Task 3.4: Documentation of 10-Year and 100-Year Storm Events (TM #3) (September 1, 2003).*** A Technical Memorandum describing the limitations and assumptions (with project conditions) used in the model development shall be provided to the District. Included in this deliverable shall be detailed descriptions of the steps and assumptions made; the C-51 discharge coefficients for the 10-year storm event; flood elevations for the 100-year storm event; tabular information on flood stages within the sub-basins; revised Figures 41-8 and 41-9 of Rule 40E-41.263; and proposed revised rule language

- Deliverables:**
- Draft Recommendation Report (TM #3)
  - Final Recommendation Report

**Task 4: Assistance During Rule Development and Rule Making**

***Sub-Task 4.1: Public Meetings Draft Basin Rules (September 1, 2003 to September 1, 2004).***

The TBE team has the experience and will assist the District as directed by attending public meetings and participating in any public outreach program as required.

***Sub-Task 4.2: Participation as Needed in Rule Development (September 1, 2003 to September 1, 2004).*** The TBE team members will assist District staff as directed to provide computer modeling simulation parameters, results and provide as needed key basin parameters for inclusion into the rule making process.

***Sub-Task 4.3: A Final Report (September 1, 2004).*** At the conclusion of the rule making process the TBE team will prepare and collate a final report including at a minimum data collection, basin parameters, model simulations results, GIS, graphics and final results of modeling, public meetings and rule making processes.

***Sub-Task 4.4: Final Model(s) and Data (September 1, 2004).*** The final model and database will be provided to the District in an acceptable electronic format. Special provisions will be required for proprietary models when specific electronic code is not provided.

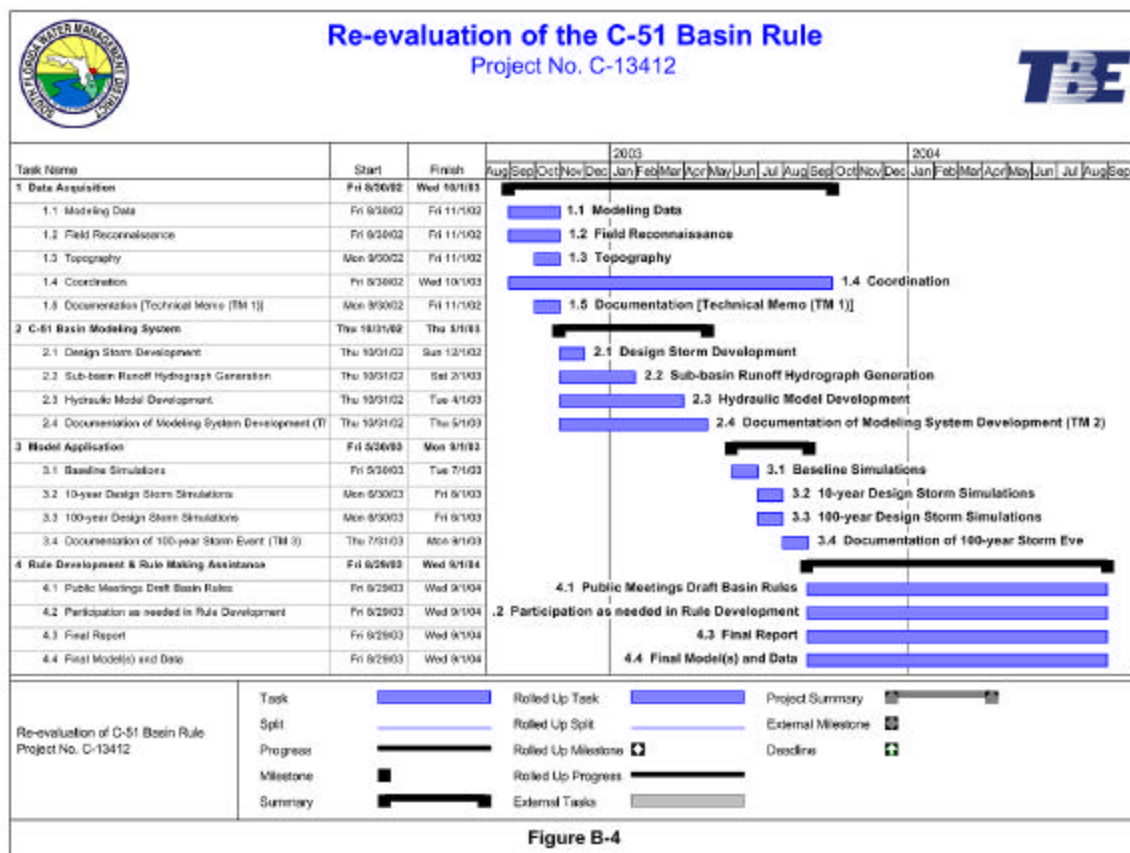
- Deliverables:**
- Assist and Attend Public Meetings
  - Update Draft Basin Rule
  - Draft Final Comprehensive Report
  - Final Comprehensive Report
  - Final Models and Data Files

**Task 5: Project Management and Quality Control (September 1, 2002 to September 1, 2004)**

Project management is occurring continuously throughout the life of project. Bi-weekly team progress meetings will be held to ensure that schedule, budget and performance goals are being met. The project manager and critical staff will attend monthly progress meetings with the District. A monthly progress report including schedule with progress shown will be submitted at these meetings in electronic and hard copy format.

- Deliverables:**
- Bi-weekly updates
  - Monthly progress meeting with the District
  - Monthly Progress Report

# Project Work Plan Reevaluation of the C-51 Basin Rule



## **Section B. Summary of Coordination and Meeting Minutes**

TBE participated in over twenty meetings and data collection sessions in order to gather the latest community knowledge and information on basin conditions, changes and future planning. These sessions were as follows:

- August 30, 2002 – First session with Mock, Roos & Associates (SFWMD)
- September 4, 2002 – Project Kick-Off Meeting at SFWMD Headquarters
- September 17, 2002 – Meeting with Lake Worth Drainage District (Delray Beach)
- September 17, 2002 – Meeting with Shalloway, Foy, Raman & Newell (West Palm Beach)
- September 18, 2002 – Second session with Mock, Roos & Associates (West Palm Beach)
- September 18, 2002 – Meeting with Loxahatchee Groves Water Control District (Loxahatchee)
- September 18, 2002 – Meeting with the Village of Wellington (Wellington)
- September 19, 2002 – Meeting with Palm Beach County (SFWMD)
- September 24, 2002 – Continued coordination with Jacksonville USACE (email)
- September 25, 2002 – Meeting with Palm Beach County Department of Airports (PBIA)
- September 25, 2002 – Meeting with Northern Palm Beach County Improvement District (Palm Beach Gardens)
- October 8, 2002 – First session with SFWMD Regulatory staff (SFWMD)
- October 11, 2002 – Meeting with District Peer Review Committee (SFWMD)
- October 16, 2002 – Meeting with SFWMD Right-of-Way permitting staff (SFWMD)
- October 18, 2002 – Second session with SFWMD Regulatory staff (SFWMD)
- October 22, 2002 – Working session with BPC Consulting Group (Orlando)
- October 25, 2002 – Meeting with SFWMD, Jim Sturgis (SFWMD)
- November 13, 2002 – Meeting of the TBE Team (Clearwater)
- November 22, 2002 – External Technical Review Team (SFWMD)
- December 6, 2002 – Meeting with Jay Foy, ITID (SFWMD)
- December 9, 2002 – Meeting with Pat Martin, LWDD (Delray Beach)

As discussed in the meeting minutes, which follow, all of the companies and organizations that we met with were very helpful and concerned that the best data and information possible be incorporated into this study. We were provided with historical perspectives as well as planned future improvements, such as a new Pump Station Number 6 for Acme ID/Wellington.

In addition to these formally documented sessions there were several communications between District GIS staff and TBE in regards to the transfer of the LIDAR topographic data. TBE will use the LIDAR data to construct a Digital Terrain Model, DTM, of the

basin that can be used both within this study's modeling efforts but also by the District and its other contractors. The DTM will be available for review in December 2002.

## **Section C. Secondary Connection Inventory**

### **1. Right-of-Way Permit Inventory:**

TBE reviewed the SFWMD Right-of-Way permit data and the Inventory Books for the C-51 canal. A tabulation of the permitted, and un-permitted, connections through the north and south banks of the C-51 canal from S-5AE on the west end to S-155 on the east end is shown on the attached eight pages of tables. Several of the connections on the south side of the canal in the first 4 miles east of S-5AE will be removed when STA-1 East is constructed as these facilities were installed by and permitted to the previous land owners.

**2. Field reconnaissance of secondary connections:** During the month of October 2002, TBE staff conducted a visual survey of key secondary structure connections in order to gain a first-hand feel for the type and condition of structural controls that are physically in-place for controlling sub-basin inflows.

- a. Beginning on the west end of the C-51 canal at the S-5AE gated-culvert structure, which is owned and operated by the SFWMD:





The main purpose of this structure is to provide for the release of water for irrigation purposes into the western reaches of the C-51 canal. This structure has very little utility for providing for the removal of flood waters from the C-51 basin.



Looking eastward down the C-51 canal from the S-5AE structure the water is being released into the basin for irrigation purposes. In the upper right of this photograph is the former sugar cane fields that will become the STA-1 East stormwater treatment area and recipient of discharges from the S-319 Pumping Station.

It is important to understand that the S-5AE structure is really only capable of directing water from west to east for the simple hydraulic reason that the stage on the eastern side is almost always lower than the stage on the western side. The stage on the western side is normally governed by the stage in either the Loxahatchee Wildlife Refuge, Water Conservation Area 1, or the stage in Lake Okeechobee. Only under extremely rare circumstances has water ever flowed from the C-51 basin westerly through this structure. As a result, any capacity of S-5AE to provide flood protection must be ruled out in the subsequent basin modeling efforts.

Proceeding eastward from S-5AE down the C-51 canal, we observed the outfall structure for the M-2 Canal Basin. This triple barrel culvert structure serves both the Indian Trail Improvement District's M-2 Basin and the Seminole Water Control District. From a

historical perspective it is important to know that the Seminole Water Control District is also commonly known as the Callery-Judge Groves.



As we proceeded further east we came to the Flying Cow Road Bridge:



Looking back westerly from this bridge we observed the condition of the C-51 canal. On the right hand side of the photograph it can be observed that the vegetation on the north canal bank has been treated with herbicide in preparation for the impending canal enlargement project that will be accomplished as part of the S-319 Pumping Station works.



Looking eastward from the Flying Cow Road Bridge:



On the east side of the bridge we find the first outfall from the Loxahatchee Groves Water Control District: A triple barrel culvert connection through the north bank.



This is the outflow point into C-51 under SR-80 of the A-Canal Structure for the Loxahatchee Groves WCD. Here we see the upstream side of this water control structure.



The next structure we observed was the D-Road Spillway of the Loxahatchee Groves WCD. Here we see this structure looking northward from its downstream side:





This discharge from this control structure flows into C-51 through a bridge under SR-80 as shown:



The next major inflow control structure we observed on this field investigation was the dual Amil gate outfall facility of the M-1 canal located on the north side of C-51. This structure has been modified such that the westerly gate has its discharge capacity controlled by vertical slide gates on its upstream face. The normal operation of an Amil gate is that it is hydraulically balanced to maintain a constant upstream water level, in this case 14.0 feet NGVD. With the slide gates in front of the western gate, its discharge is controlled manually by the Indian Trail





Improvement District in accordance with a MOU with the SFWMD. Generally, the upstream water level in this reach of the M-1 canal is maintained at about 13.5 feet NGVD by a pair of culverts under SR-80 just east of this structure at the confluence of the Royal Palm Beach Lake and C-51:



The next secondary connection of note east of M-1 is the NPBCID structure which controls the CPB-20A canal system: This concrete weir structure controls the water level



in the area that used to be designated as Sub-basin 17 in the original 1984 study. This facility has been transferred for operation and control to the Village of Royal Palm Beach. It controls inflows to C-51 from areas north and south of Okeechobee Boulevard.

Actually just east of this canal and spillway is



another small ditch and culvert outfall discharging under SR-80 into the C-51 canal. The



outfall structure for the NPBCWCD/RPB canal is shown in the upper right of this photo with the smaller ditch and culvert in the foreground. For perspective, this photo was taken on SR-80 looking northwest towards the NPBCWCD/RPB structure.



As we progressed eastward the next major water control facility shown here is the S-155A divide structure under construction. This structure is located approximately 800 feet west of SR-7 on the south side of SR-80. The main purpose of this structure is to protect the eastern C-51 basin from excessive inflows from the western basin during severe storm events. A key component of the modeling in this study



will be dependent upon the technical interpretation of the words “excessive inflows” and “severe storm events” as related to S-155A operations. After completion of construction of the hydraulic model by inputting the physical component information TBE will meet with both SFWMD and USACE operations personnel to define the operational protocols to be utilized in the modeling.

Continuing eastward from SR-7 we came to this control structure for the LWDD E-1 canal on the south bank of C-51:



This is a two-bay radial gate structure that controls the discharges on both the east and west sides of SR-7 from as far south as the Homeland development.

The sub-basin configurations south of the C-51 canal which are contributory to this structure are amazingly complex as the result of development patterns and the implementation of the C-51 Basin rule which severely restricted any outflows from much of the area. As a result, many small, and some not so small (as large as a square-mile), developments have chosen to move forward by discharging into the Acme Improvement District pumped canal systems in lieu of the LWDD gravity system. However, because of the C-51 Basin Rule, the AID/Wellington system was not given additional pumping capacity to serve these lands so they had to incorporate significant on-site water storage facilities into their designs.

Continuing eastward, we found the outfall control structure for the LWDD E-2 canal on the south bank of the C-51 canal. This is also a two-bay radial gate structure that controls a significant area south of C-51 on both sides of the Turnpike:



There exists significant basin storage upstream of this structure by virtue of the fact that Okeeheelee Park is within the contributing sub-basin. All of these control structures east of SR-7 will have significantly better hydraulic performance simply by virtue of the implementation of the S-319 Pump Station/STA-1East and S-155A Control Structure projects. There will be significantly lower tailwater conditions that should improve their discharge efficiency. The USACE design for the C-51 canal system is based upon providing 10-year flood protection for the western basin and 30-year protection for the eastern basin. This is particularly significant for the Lake Worth Drainage District because essentially all of their secondary canal network has been based upon a 25-year storm design level.

Continuing past the Turnpike, moving eastward, the next major secondary water control structure that is encountered is the LWDD E-3 canal outfall, as shown. This structure is a triple-bay radial gate structure that provides outfall control for a highly developed watershed east of Jog Road and west of Military Trail.





As can be seen from this photo, there is very little vacant land remaining as a percentage of this sub-basin. There are several significant inflow connections along the north canal bank east of here, but the eastern basin of the canal is controlled on its eastern end by the S-155 Spillway:



This control structure replaced what was locally known as the Palm Beach Locks in the early 1980s. The locks were constructed here because at the time the C-51 was called the West Palm Beach Canal and was used as a navigable waterway to transport vegetables from the rich agricultural lands inland eastward to the port in Palm Beach.



Details on these structures as well as the pumping systems of Wellington and the Palm Beach international Airport are contained in the 150+ reports that TBE has in the, previously described, six-volume set. In the next section, we will discuss some of these details as well as summarize a lot of the relevant permit data that we accumulated during this investigation.

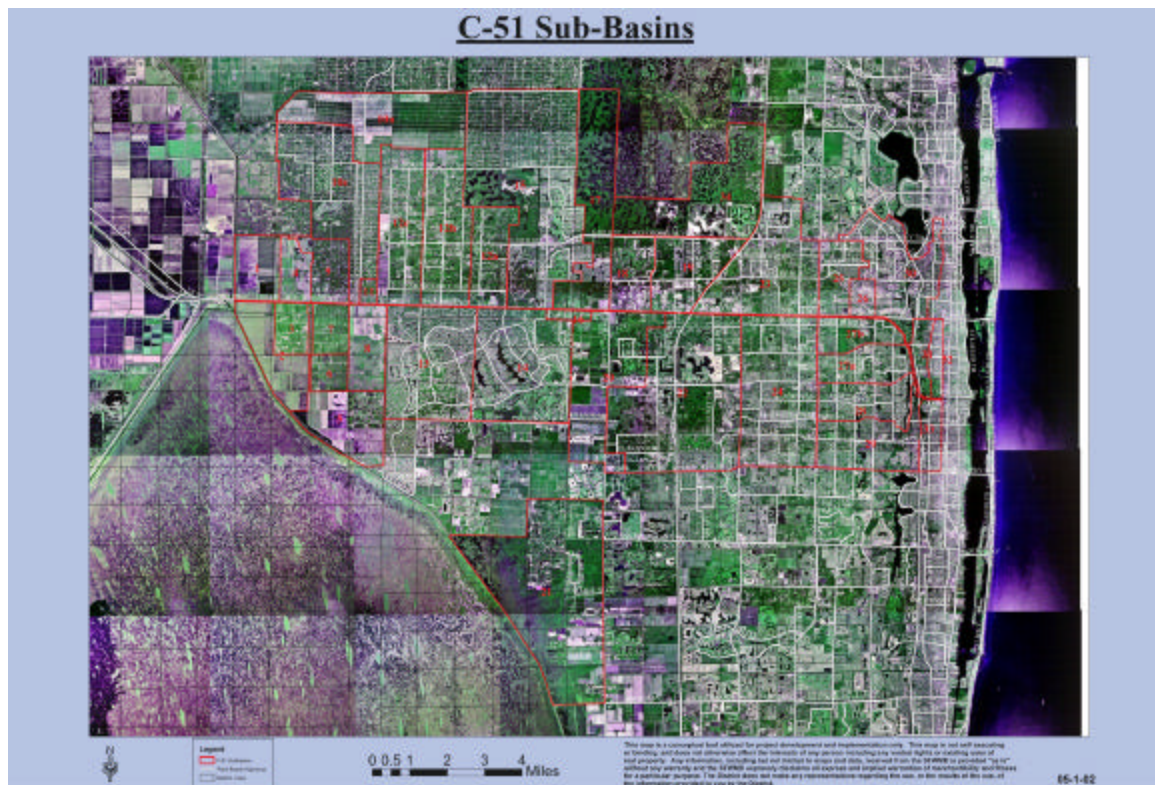
## **Section D. Permit Data Collection and Review**

1. **Regulatory GIS Database** – TBE reviewed the data in the SFWMD Regulatory GIS Database and identified 8 Quad Sheets that covered the C-51 Watershed. The District printed out the aerial-Quad sheets based upon two selection criteria: Individual Surface Water Management/ERP Permits and General Surface Water Management/ERP permits. Upon review of these aerial sheets TBE identified 132 Individual and 35 General Permits for review. These permits were either for large parcels or for projects that were adjacent to a suspected sub-basin boundary. The District then printed out staff reports from the permit files for the majority of these projects. There were some permits that had too many modifications, such as Permit 50-00548 (Wellington), that it was more efficient for TBE staff to come to the Regulatory “Vault” area and review the permit files there and then decide which data to extract for the study.
2. **Permit Staff Reports** – TBE reviewed over 150 staff reports plus modification reports for developments within the C-51 Watershed. This included projects equally distributed within the eastern as well as the western basin. It was quite interesting to note how significant the impact of the existing C-51 Basin Rule has been on the design of storm water management systems. This experience will be invaluable when developing the next version of the rule as we will be better able to describe the impacts of the rule parameters on future development within the basins.
3. **Sub-Basins Affected By Permitted Activities** – There were many significant changes that occurred to the sub-basins within the C-51 watershed between the 1984 study and today. Some changes were a direct result of the Basin Rule setting a no-discharge limit on specific parcels. Other changes dealt with the creative ways in which designers chose to meet the flood plain encroachment criteria. The following four pages list the significant permit actions that have affected the delineation of sub-basins within this watershed. Shown in these tables by permit number are the sub-basin which the property was in during the 1984 study and the new sub-basin designation in which the site is recommended for this study and modeling effort.

TBE incorporated all comments and data which was received at our numerous coordination meetings and believe that this is an excellent representation of the data collected. A more detailed discussion of the sub-basin delineations will occur in Section E. Also, in Section E are two maps delineating the 1984 sub-basins and our recommended sub-basin delineations for this study.

## **Section E. Sub-basin Boundary Discussion**

1. **1984 Study** – The sub-basin designations in the early study were as shown below:



Several of these sub-basins represent parcels of land that, today, do not drain into the C-51 canal but did in 1984. For example, Sub-basins 2, 3, 5, 6, 7 and 8 cover portions of the proposed Stormwater Treatment Area 1-East (STA-1E). Portions of Sub-basin 3 will be pumped directly into STA-1E without discharging into the C-51 canal first. Portions of Sub-basin 34, north of Okeechobee Blvd. and west of the Florida Turnpike will no longer contribute any storm flows to the C-51 canal either. A significant amount of development activity has occurred since 1984 along the State Road 7 (SR-7) corridor which has substantially modified the size and configuration of Sub-basin 20.

Palm Beach County and the City of West Palm Beach have done significant work in the redesign and improvement of drainage facilities east of Military Trail and north of the C-51 canal. Mock, Roos and Associates, on behalf of the City of West Palm Beach has done extensive analysis and design work in these areas. As their detailed Stormwater Master Plan is included, on CD, in the back of this report, we will not attempt to duplicate that information here. The Palm Beach Department of Airports, likewise has done extensive design work on improving the drainage within the PBIA boundaries as well as providing for off-site inflows from north of Belvedere. Their re-aligned drainage patterns for the airport has significantly changed Sub-basins 25, 26 and 30. (See exhibit on next page for an illustration of this realignment.)



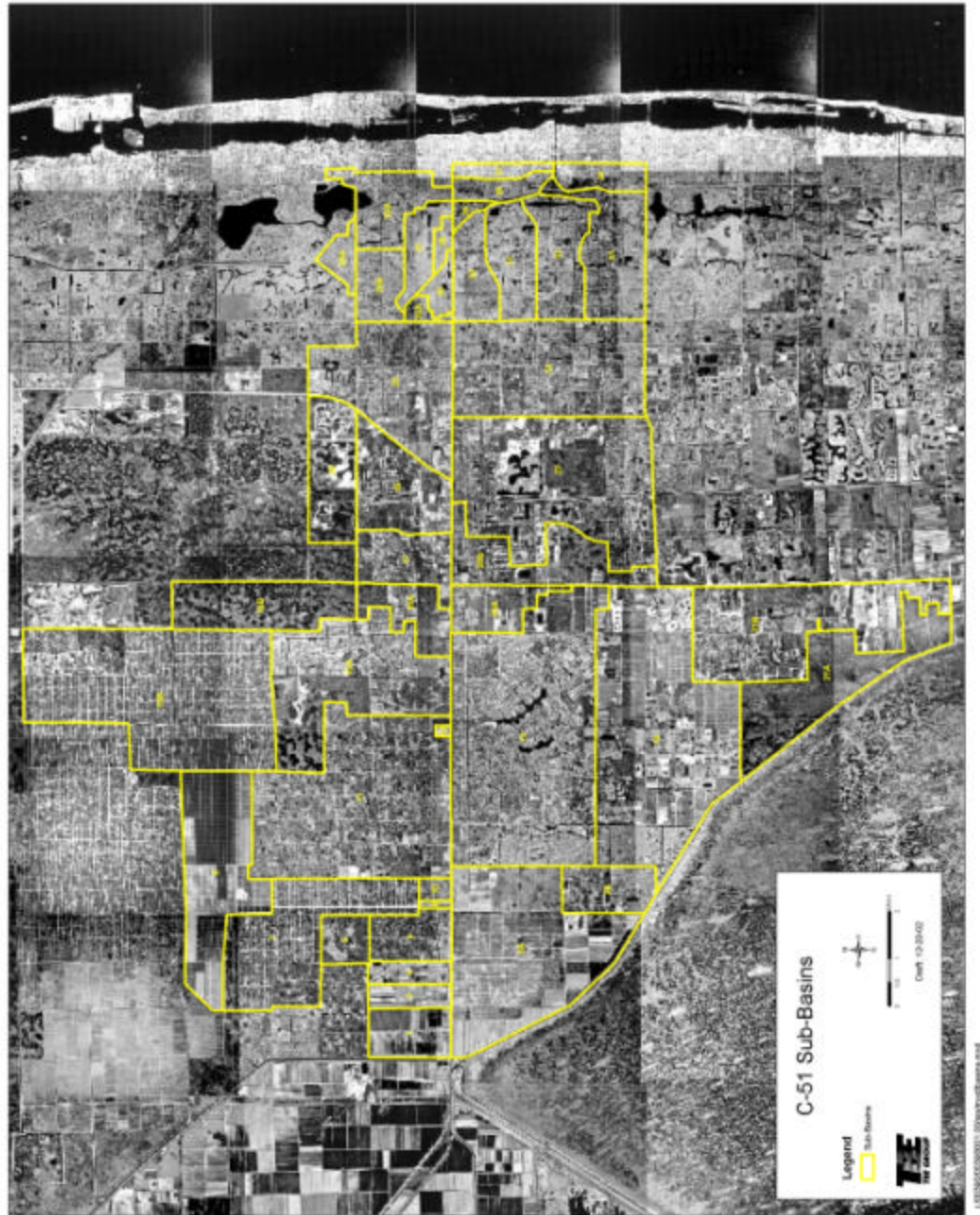
The PBIA facility will now essentially be covered by 4 sub-basins in the new study for the Basin Rule.

Sub-basin 15, which was the M-1 canal basin of the Indian Trail Improvement District south of the M-canal, will now be represented by two sub-basins in order to accurately account for the hydrologic and hydraulic differences between the southern system serving the Village of Royal Palm Beach, and a northern system serving the M-1 Acreage Area. In 1984, there was no control structure at the north end of the Village system which would allow for inflows from the Acreage area. The first attempt at alleviating severe flooding in the Acreage was the installation of the 40<sup>th</sup> Street Structure subsequent to a major localized flooding event that affected the Acreage but had no effect on the Village.

Sub-basin 17, which goes from C-51 north to the M-Canal along the west side of SR-7, was anticipated to undergo significant development pressures in 1984. Many changes in this sub-basin occurred between then and now that has made the delineation of this sub-basin boundary no longer valid. More details of this and other significant changes will be included in the next sub-section on the recommended sub-basin boundaries.

2. **2002 Study** – The delineation of sub-basins for the purpose of modeling both the existing conditions and a proposed “improved” set of conditions is to some extent science and to some extent art. The TBE recommended sub-basin boundaries for modeling purposes under this contract are as shown on the next page:





The new recommended sub-basin boundaries are representative of the comments and information that TBE received in the numerous coordination meetings as well as our detailed review of over 150 SFWMD permit files. A detailed discussion by sub-basin will follow:

Sub-basin 1 – is the same size and configuration as it was from the 1984 study. It represents the area and facilities of the Palm Beach Aggregates property as delineated in their SFWMD Permit 50-00281.

Sub-basin 2A – is the Stormwater Treatment Area 1-E site. It combines much of the lands from what was 6 sub-basins in the 1984 study. Obviously, the key facility associated with this sub-basin, for modeling purposes, is the S-319 Pumping Station which will be located on the north boundary with an installed capacity of 3,980 cfs for removal of flood waters from the C-51 Basin.

Sub-basin 2B – is the Rustic Ranches development and Section 24 property, which is owned by the SFWMD. It will not contribute flows to C-51 for the purpose of this study as it will be pumped directly into STA-1E as part of the implementation of the federal flood control project.

Sub-basin 3 – is the Fleming Property which was issued a permit by SFWMD for separate discharge facilities, Permit 50-02709, from the adjacent parcel which is owned by Leonard. In the 1984 study these two parcels were combined with a single pumped discharge.

Sub-basin 4 – is the Leonard Property which is the eastern portion of the former parcel which now has a separate discharge facility as authorized under SFWMD Permit 50-00894.

Sub-basin 5 – is the development which was formerly covered by Sub-basin 9 in the 1984 study and is represented by the SFWMD Permit 50-00121. It has gone by the designation of the Fox Trail Subdivision in the past

Sub-basin 6 – is the Lion Country Safari Theme Park. It was formerly designated as part of Sub-basin 10S in the 1984 study but we are recommending that it be handled as a separate sub-basin because of the discharge control facilities installed as part of their SFWMD Permit 50-00374.

Sub-basin 7 – is the balance of former Sub-basin 10S minus the Lion Country Safari lands and facilities. It is generally identified as the M-2 Acreage Area of the Indian Trail Improvement District. It also includes projects not a part of the M-2 Acreage, such as the Dellwood Gardens project, which drain into the M-2 system. Most of the facilities are covered by the SFWMD Permit 50-00754.

Sub-basin 8 – is the Seminole Water Control District which is also known locally as the Callery-Judge Groves. This sub-basin was designated as 10N in the 1984 study as it is separate from the M-2 Acreage system but also utilizes the M-2 canal as its major outflow route. The facilities are covered by one of the oldest permits in the records, SFWMD Permit 50-00021.

Sub-basin 9 – is property assigned to Richard Sluggett in accordance with SFWMD Permit 50-00909 and it has a discharge connection into the M-2 Canal.

Sub-basin 10 – is property known as Entrada Acres and its discharge facilities are covered by SFWMD Permit 50-00564.

Sub-basin 11 – is the Loxahatchee Groves Water Control District property. SFWMD Permit 50-01682 covers the discharge facilities which serve this property. In addition, Crossroads Engineering performed a detailed hydrologic and hydraulic study of this sub-basin and is described in detail in their report, District Wide Flood routing and Drainage Basin Study, prepared for: Loxahatchee Groves Water Control District, August 31, 2000.

Sub-basin 12 – is the Palms West Hospital Property which is shown separately in this study as it has a separate drainage connection to C-51 and is not served by the Loxahatchee Groves WCD facilities. These facilities are described in SFWMD Permit 50-01252.

Sub-basin 13- is the Acme Basin A sub-basin. It was shown in the 1984 study as two separate sub-basins because of the two pumping stations on the north side, AID Pump Stations #3 and #4. However, in discussions with local experts we recommend that this sub-basin be included as a single contributor with multiple discharge facilities. The canal and lake system of Wellington is so interconnected that water can relatively freely move towards either pump station. In addition, Wellington is in the process of seeking approval for a third pumping station, Pump Station #6 at the northeast corner which will also share the storm water management needs of Acme Basin A. The eastern boundaries of this sub-basin have been modified somewhat from the 1984 boundary in order to reflect the additional properties that have chosen to remove themselves from the former Sub-basin 20 system and entered into agreements with the Village to handle their discharges.

Sub-basin 14 – is not included in the current modeling plan at this time. This number was originally used for the western half of Basin A, but as described above, is not necessary for this analysis. We felt that, in recognition of the need for consideration of Basin B discharges in the near future, this number should be held for Basin B to allow incorporation into an easily revised modeling scenario by others. (Note: TBE will be providing the C-51 model and all data sets, both input and output, to SFWMD and any of their other CERP contractors who may wish to use it for solving additional basin problems outside of the scope of this study.)

Sub-basin 15A – is the Village of Royal Palm Beach and other properties south of the M-1 Acreage Area which contribute inflows to the M-1 canal of Indian Trail Improvement District. This system is covered by several SFWMD Permits with the main facilities described in Permit 50-00618.

Sub-basin 15B – is known as the Lower M-1 Acreage Area and represents the properties north of the Village of Royal Palm Beach which are capable of delivering storm water to the M-1 Canal downstream of the ITID pump station which is approximately one mile north of the M-Canal of the City of West Palm Beach. Due to the configuration of roads and canals north of the Village, it is feasible that runoff from as far north as Northlake Boulevard is included in this basin. For example, the Stonewal and Kramer developments discharge into the ITID system which extends north almost to Northlake Boulevard. This sub-basin therefore includes almost 13 square miles of properties.

Sub-basin 16A – is formerly the Northern Palm Beach County Improvement District Canal-20A. This area has had several permit actions since 1984 which have modified the service area. It represents the portion of the 1984 Sub-basin 17 south of Okeechobee Blvd. Since Okeechobee Boulevard was enlarged and widened there no longer exists the ability to move significant water from north to south, or vice versa.

Sub-basin 16B – for all modeling intents and purposes this sub-basin does not contribute significant stormwater to the C-51 canal system during storm events. It is, for the most part, owned by Palm Beach County and managed as a wetland natural preserve system. It is covered by SFWMD Permit 50-05422 which only allows for emergency discharges into the Village of Royal Palm Beach canal system, formerly designated as NPBCID Canal 20-A, described above.

Sub-basin 17 – is very similar in size and boundaries as the former Sub-basin 18 with consideration of permitted facilities which modified its western boundary, such as the commercial facilities covered by SFWMD Permit 50-01172.

Sub-basin 18 – is the same size and configuration as the 1984 Sub-basin 19.

Sub-basin 20A, and B – this was formerly Sub-basin 20 in the 1984 study but due to the large number of developments that have been built since then and the multitude of discharge facilities we recommend that it would be more effectively described as two smaller sub-basins interconnected via the LWDD E-1 Canal.

Sub-basin 21A and 21B – is the same size and configuration as the 1984 designation for sub-basin 21. There is some benefit for modeling purposes in separating it into two parts with the Strazulla Wetlands as Sub-basin 21A, and the balance which runs along State Road 7 as Sub-basin 21B. This is due to both the lack of a positive outfall for Strazulla as well as the long-term plans for retention of surface waters within the Strazulla site.

Sub-basin 22 – is generally in the same location as it was from the 1984 study, but it has been reduced in size as a result of the multitude of developments along the SR-7 corridor that have re-routed some discharges in the area. As a result the



western boundary of this sub-basin is recommended to be modified as shown for this study.

Sub-basin 23 – is identical to the boundaries used in the 1984 study. We found no significant information, permit or other local data which would lead us to recommend a different configuration.

Sub-basin 24 – is also identical to its size and shape as it was in the 1984 study. We believe that this is the case because of the detailed and effective permitting program of the Lake Worth Drainage District which has historically maintained drainage divides and facilities in accordance with their master plans. This area, as well as Sub-basin 23, above, is covered in their master stormwater permit from SFWMD Number 50-01578.

Sub-basin 25A – is generally identified as PBIA sub-basin 1 in the airport master plan document. It was formerly the Town of Golfview until the entire area was purchased by the County. It is connected to Sub-basin 25B by what is known as the E-31/2 Canal which runs along the west boundary of the Airport adjacent to Military Trail, see photo, below:



This sub-basin is bounded on the west by Military Trail and on the north by Belvedere Road.

Sub-basin 25B – is the area north of Belvedere Road which is served by the E 31/2 Canal, described above. This area is generally the drainage responsibility of Palm Beach County, who has undertaken facility improvements since 1984 to alleviate severe flooding of the older developed areas. This sub-basin could be divided at Congress Avenue with the eastern portion being included in Sub-basin

29A. We are interested in the input from the Technical Review Team as to the desirability of modifying the subbasin boundaries for this modeling effort.

Sub-basin 26 – is entirely within the Palm Beach International Airport Property and is controlled by facilities permitted under SFWMD Permit 50-00471.

Sub-basin 27 – is also a PBIA sub-basin with discharge controlled by facilities authorized in SFWMD Permit 50-00471.

Sub-basin 28 – is the PBIA sub-basin and part of the I-95 interchange facilities which contribute to this system.

Sub-basin 29A – is predominately the Renaissance project area of the City of West Palm Beach as described in the Stormwater Master Plan prepared by Mock, Roos and Associates.

Sub-basin 29B – is the northernmost area contributing flows to the Stub Canal system and is also described in detail in the Mock, Roos study.

Sub-basin 30 – is the area described in the 1984 study as Sub-basin 27B. It includes several projects such as the SFWMD Headquarters Complex, Lake Lytal Park, the Trump Golf Club, the Armory and the Palm Beach County Criminal Justice Center.

Sub-basin 31 – is the area described in the 1984 study as Sub-basin 27A. Its size, discharge facilities and boundaries have not changed significantly since 1984.

Sub-basin 32 – is the area described in the 1984 study as Sub-basin 28. Its size, discharge facilities and boundaries have not changed significantly since 1984.

Sub-basin 33 - is the area described in the 1984 study as Sub-basin 29. Its size, discharge facilities and boundaries have not changed significantly since 1984. All three of these areas were essentially in full build-out in 1984 and there has been very few system changes since then other than the completion of the S-155 Spillway and its operational improvement over the former Palm Beach Locks Structure.

Sub-basin 34 – is the portion of the City of Lake Worth that was identified as Sub-basin 33 in the 1984 study. It was fully developed in 1984 and few significant changes have occurred to the stormwater facilities that would affect our proposed modeling efforts.

Sub-basin 35 – is the Town of Cloud Lake which has its own discharge facilities connected to the Stub Canal.

Sub-basin 36 – is predominately the Dreher Park area and surrounding residential properties which discharge into C-51 through facilities outlined in the Master Stormwater Plan for the City of West Palm Beach. Note that the boundaries on this drawing are shown schematically for this area as well as the others covered by the City's Master Plan. The actual area and facility information contained in the 1300-page Master Plan document will be used for modeling purposes.

Sub-basin 37 – is the City of West Palm Beach Golf Club and surrounding residential areas. The detailed information in the above described Master Plan will be incorporated into the modeling for this study.

Sub-basin 38 – is the area north of Okeechobee Blvd. and west of the Florida Turnpike. It was formerly identified as Sub-basin 34 in the 1984 study. Its size has essentially been cut in half since the 1984 study, as much of the land now drains into the Water Catchment Area of West Palm Beach. The major developments contained in this modified sub-basin are Andros Isle, Riverwalk and Vista Center. The western and northern boundary may be modified somewhat as a result of the permitted facilities for the Andros Isle project. After review with the External Technical Review team it was agreed that the northern boundary used in the modeling would be as shown.

The above detailed descriptions of the proposed sub-basins give an idea of the magnitude of the information and data which was collected and reviewed so far for this study. As previously described, we have six volumes of reports that detail permitted facilities and sub-basin studies of the area. We believe that the sub-basin breakdown shown in this section and the large-scale map in the back pocket of this report represents an accurate depiction of the secondary facilities which should be incorporated into this modeling effort for the Reevaluation of the C-51 Basin Rule.

## **Section F. Land Use/Soils Data Collection**

Enclosed in the back of this report, on CD #4, are GIS databases of land use and soils data for the Palm Beach County Area. In addition, an electronic copy of the NRCS Soil Survey Report for Palm Beach County, on CD # 5, is also included in the back for use.

For modeling purposes, this data combined with the detailed land use, topography and soils information that has been compiled for Indian Trail Improvement District by Shalloway, Foy, Raman & Newell, for the City of West Palm Beach by Mock, Roos and Associates, and for the Loxahatchee Groves Water Control District by Crossroads Engineering as detailed in the reports and studies which were collected during the coordination phase should be adequate.

The utilization of the land use/land cover information and soils data in hydrologic modeling is specifically for the purpose of determining an effective Runoff Relationship for each sub-basin. In the HEC-HMS modeling process this is generally represented by a Runoff Curve Number (CN). The Curve Number approach to hydrologic modeling originated with the predecessor agency to the Natural Resource Conservation Service, known as the Soil Conservation Service (SCS). The SCS utilized their in-depth knowledge of the water/rainfall relationships of soils combined with their extensive Soil Survey development program to establish the Runoff Curve Number approach to predicting storm water runoff volumes and rates.

In the mid-1970s the SFWMD worked with the Florida State Conservationist to develop an approach for relating Curve Numbers to the availability for moisture storage in the upper 4-foot soils layer of south Florida land. This approach was incorporated into the SFWMD Basis of Review criteria handbook and users manual. It is also important to note that the validity of the approach was subsequently documented by a University-sponsored study which compared the predictive accuracy of the SFWMD method to most common runoff-predicting methods. The method was developed in the District's regulatory process and was known schematically as the DRM method, District Regulatory Method.

In the construction of the hydrologic model of the C-51 basin TBE will use the best available information for each sub-basin to assign appropriate Curve Numbers. For those basins in which a tremendous amount of work has already been done, such as Indian Trail I.D., Loxahatchee Groves WCD and the City of West Palm Beach we will use that data.

## **Section G. Topography/LIDAR Data Collection and Processing**

Significant work has been done by both Palm Beach County and the U.S. Army Corps of Engineers in the collection of topographic data for the C-51 Basin.

This data, generally known as LIDAR, has been compiled by the District and is being made available to TBE for use in this modeling effort. We are currently in the process of inputting the data into our computer system for GIS application. Our team has produced a Draft Digital Terrain Model (DTM). This model will then be linked by our modeling experts to the hydrologic and hydraulic modeling programs to generate detailed elevation-storage relationships for flood routing within the sub-basins and throughout the watershed. The DTM will provide useful information to ascertain the movement of flood waters between sub-basins for the more severe storm events modeled, such as the 100-year event.

The DTM will be used in its GIS form for producing visual outputs from the modeling which can identify flooding “hot spots” as well as be used by Palm Beach County as they appeal the latest FEMA flood study results.

The completed DTM will be given to the District for use on their other resource studies such as the CERP program.

## **Section H. Hydrologic and Hydraulic Data Collection**

Enclosed in the back of this report on CD #10 in Folder “C51 Mod” is hydrologic and hydraulic data from the District’s DBHYDRO database system. The data is daily stage and flow data from the following sites:

<b><u>DBKEY</u></b>	<b><u>STATION</u></b>	<b><u>VALUE</u></b>	<b><u>PERIOD</u></b>
00332	S155-HW	DAILY STAGE	10/01/69 to 07/31/96
06772	S155-HW	DAILY STAGE	02/19/86 to 08/02/98
05116	C51-WEL	DAILY STAGE	06/13/73 to 03/03/92
15706	C51-WEL	DAILY STAGE	09/28/93 to 07/30/98
FI281	C51-SR7	DAILY STAGE	07/24/97 to 07/25/98
0334	S155-S	DAILY FLOW	08/30/92 to 12/31/92
03680	S155-S	DAILY FLOW	01/01/93 to 08/25/98

The purpose of this data is to provide both an historical record of stages and flows within the C-51 basin that have been observed but also to provide a standard set of data that can be used in the calibration process. Also, as part of the data compilation, the performance of the SFWMM model is shown side-by-side with the data to indicate the relative accuracy of that tool for water supply modeling. The performance of the HEC-HMS and HEC-RAS modeling combination will much more accurately represent the actual and predicted performance of the C-51 canal basin and related facilities. Not only will these models be at a much finer scale than the SFWMM but they will provide event-based information rather than the long-term continuous modeling benefit of the SFWMM.

On the next few pages are the HEC-RAS data sets which the U.S. Army Corps of Engineers, Jacksonville District used for modeling both the existing conditions in the western basins but also their anticipated finished facility, or proposed improved channel conditions, data set. These sets include channel data as well as useful bridge crossing data for the HEC-RAS simulations in our study. Attached to the back of this report, on CD #10, are the data sets used by the FEMA contractors for modeling the performance of the C-51 canal during a 100-year storm event. The data sets are in UNET format and hence can also provide valuable data for this modeling. In order to make the most use of these data sets we have also included CDs with the key programs, HEC-HMS, HEC-RAS and UNET.

Hydrologic and hydraulic data developed for the C-51 project by the U.S.A.C.O.E. are contained in the Detailed Design Memorandum for the project, Part V, Supplement 54, Addendum 2 (revised), February 1998. Rather than reproduce that data here we are just giving the above reference, as it is public information and widely distributed by the Corps.

## **Section I. Discussion of Related Studies**

1. **FEMA** – the Federal Emergency Management Agency produced a “new” Flood Insurance Rate Study for Palm Beach County which has been received with much unrest in the elected and professional communities. The modeling for the C-51 basin in this effort was accomplished using the UNET model. There was not major disagreement over the use of the model only over the operational assumptions that were made in its use. (For reference purposes we have attached the FEMA modeling data as the FIRM maps produced on CDs in the back of this report.)

The FEMA contractor assumed that, even though the S-155 Spillway existed and had the capability to discharge in excess of 5,000 cfs under 100-year type flooding conditions, it was closed and inoperable during the storm event. This, of course, resulted in significantly higher stages throughout the basin than any local water resource professional would have ever believed reasonable. The County, with assistance by SFWMD requested that FEMA reevaluate their position on the study and, in fact, redo it. As a result of several meetings and discussions, FEMA has agreed to re-run the UNET model with S-155 operational but not to redo the whole study again.

The County is hoping that this study, by virtue of the fact that HEC-HMS, HEC-RAS and UNET are all FEMA-approved models for flood studies, will be useful in convincing FEMA to “correct” the flood level deficiencies identified on the FIRMs, Flood Insurance Rate Maps.

2. **USACE/STA-1E Design** – the design of the C-51 project and associated pumping facilities has been ongoing since the late 1960s. The latest project concept is the improvement of the channel from west of SR-7 to the new S-319 Pumping Station, the construction of an east-west basin “divide” structure near SR-7, S-155A, and the construction of a detention/treatment reservoir called STA-1E.

All previous design concepts failed to secure either the necessary state and federal permits or the funding commitments. As a result, today these facilities are under full-bore construction except the channel enlargement which has not yet begun. As there is still some discussions ongoing between the USACE and SFWMD (personal communication with Jim Sturgis) we will use the design sections as given to us by Trent Ferguson, USACE on September 24, 2002.

There are several subsequent design documents issued after the previously referenced 1998 Detail Design memorandum, but these newer documents deal with the internal physical and operational details of the Stormwater Treatment Area. They do not affect the sizing or location of the S-319 Pumping Station or the STA-1E so they are not important to this modeling effort. The main purpose of this modeling effort is to effectively and accurately show how the discharges

and stages in the many sub-basins previously described change as a result of the implementation of the COE project.



## **Section J. Next Phase of Study :**

The next phase of this study is to build the necessary hydrologic and hydraulic data sets for the HEC-HMS and HEC-RAS models, generate runoff hydrographs and construct a calibrated modeling system for the basin:

1. Initially we will generate a recommended set of rainfall ordinates to be used in the HEC-HMS model for the 10-year and 100-year, 72-hour design storms. With input and advice from SFWMD staff we will consider the use of areal adjustment factors for the rainfall amounts.
2. After receipt of feedback from the SFWMD and the Technical Review team we will compute the sub-basin acreages, determine percentages of impervious cover, soils and compute appropriate runoff curve numbers.
3. Using the runoff curve numbers, sub-basin acreages and the rainfall hyetograph data we will use HEC-HMS to generate sub-basin runoff hydrographs for both design storms.
4. We will develop the necessary structural input data files for the HEC-RAS model for each sub-basin outflow facility as well as for the main channel, C-51, bridge crossings, S-155A, S-155 and S-319 Pump Station.
5. With input from SFWMD staff we will calibrate the HEC-RAS model with best available data. This calibration may consist of discharge rate comparisons or observed-versus predicted stage profiles.
6. We will provide a technical memorandum to the District, documenting the modeling system development, insights gained during testing of the modeling system, sensitivity analyses and any limitations the modeling system may have.

**Section K. Electronic Data Sets:**

1. HEC-HMS Model
2. HEC-RAS Model
3. UNET Model
4. GIS data-files – Soils and Land Use
5. NRCS P.B. County Soil Survey
6. P.B. County FIRM – Volume 1
7. P.B. County FIRM – Volume 2
8. City of West Palm Beach Storm Water Master Plan
9. PBIA Strategic Master Plan Study
10. C-51 Model Calibration Data/PBIA Aerial Photos/PBIA ALP/FEMA HEC-1 and UNET data files
11. Electronic Copy of this Report –Technical Memorandum #1